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Effect of tropically adapted sire breeds on preweaning growth of F_1 Angus calves and reproductive performance of their Angus dams[1,2,3]

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ABSTRACT: The objective of this study was to determine the effect of tropically adapted sire breeds on preweaning growth performance of F_1 calves and on reproductive performance of their Angus dams. Angus (A) cows were bred in two consecutive years (1992 and 1993) by AI using semen from Brahman (B; *Bos indicus*; n = 10), Senepol (S; *Bos taurus*; n = 10), and Tuli (T; Sanga; n = 9) bulls. A total of 82 B × A, 85 S × A, and 91 T × A calves were born. The statistical model included the fixed effects of year, sire breed, calf sex, sire breed × calf sex, and cow parity and the random effect of sire within sire breed. Birth weight, weaning weight, 205-d adjusted weaning weight, ADG from birth to weaning, and hip height at weaning were greater ($P < .001$) for B × A calves than for S × A or T × A calves. Greater differences were detected between sexes for B × A than for S × A and T × A (for all traits sire breed × calf sex, $P < .05$). Sire breed affected ($P < .01$) the percentage of unassisted calvings (B × A, 87%; S × A, 98%; and T × A, 100%) and tended ($P < .10$) to affect the percentage of calves that survived until weaning (B × A, 90%; S × A, 94%; and T × A, 98%). Sire breed of calf did not affect ($P > .10$) length of gestation, and sire breed did not affect the interval from calving to first observed estrus or pregnancy in Angus dams. These results demonstrate that preweaning growth performance of B × A calves was greater than that of either S × A or T × A calves. However, use of Brahman sires on Angus dams led to calving problems and tended to reduce the percentage of calves that survived until weaning. Thus, heavier weaning weights of B × A calves would be an advantage for cow-calf producers marketing calves, but heavier birth weights and calving difficulty attributed to Brahman sires would be a disadvantage.

Key Words: Birth Weight, Cattle Breeds, Crossbreeding, Postpartum Interval, Sire Evaluation, Weaning Weight

Introduction

Sources of tropically adapted germplasm in the United States have been generally limited to Zebu breeds (*Bos indicus*) and, within these, primarily to the American Brahman. There are alternative sources of beef cattle germplasm from other countries that are adapted to tropical environments that have not been characterized under U.S. conditions and that may offer unique traits for beef cattle production systems. As with most breeds, the potential usefulness for these breeds will be in crossbreeding systems.

In the early 1990s, Tuli semen first became available for importation to the United States from an Australian consortium. The Tuli is a Sanga breed believed to have been developed from crosses between Zebu and *Bos taurus* cattle thousands of years ago in Africa and in its native land has demonstrated high fertility and maternal performance (Oliver, 1983; Schoeman, 1989). In order to investigate the potential of the Tuli, it was recognized that evaluations would need to be concentrated in warm regions and conducted across a number of locations representative of the different climatic conditions. Evaluations of Tuli- and Brahman-sired calves were conducted at Tifton, Georgia (Baker, 1996), Clay Center, Nebraska (Cundiff et al., 1998), Las Cruces, New Mexico (Winder and Bailey, 1995), El Reno, Okla-

homa, and at McGregor (Herring et al., 1996), Overton (Browning et al., 1995), and Uvalde (Holloway et al., 1998), Texas (Herring et al., 1993). Our site at Brooksville, Florida also contributed in this evaluation as representative of a hot, humid, subtropical environment. Senepol (a *Bos taurus* breed) cattle have been evaluated under these conditions and are as heat-tolerant as Brahman (Hammond and Olson, 1994; Hammond et al., 1996; 1998). The objectives of the present study were to determine the effect of tropically adapted sire breeds, Brahman, Senepol, and Tuli, on preweaning growth of F_1 calves and on reproductive performance of their Angus dams in subtropical Florida.

Materials and Methods

This study was conducted at the Subtropical Agricultural Research Station (STARS; 28° 37′ N latitude, 82° 22′ W longitude) located near Brooksville, Florida to determine the effect of tropically adapted sire breed on preweaning growth traits of F_1 calves and on reproductive performance of their Angus dams. In the spring of 1992 and 1993, Angus (**A**) cows were bred by AI using semen from Brahman (**B**; n = 10), Senepol (**S**; n = 10), and Tuli (**T**; n = 9) bulls. Semen from all bulls were used in both years of the study. Brahman and Senepol semen was obtained from U.S. sources (commercial breeding services and purebred breeders) to be representative of current herd sire prospects. Tuli semen was purchased and imported from Australia. Tuli sires represented nine paternal lines exported from Zimbabwe to Australia as embryos in 1988.

The Angus cows used in this study may be described as average frame size and were from a long-term breeding project conducted at our location (Beltran et al., 1992). In 1992, 167 females (18 2-yr-olds, 40 3-yr-olds, and 109 4- to 13-yr-olds) were used, and in 1993, 196 females (26 2-yr-olds, 35 3-yr-olds, and 135 4- to 12-yr-olds) were used. Of the 2- and 3-yr-olds, in 1992, 3 of 18 2-yr-olds and 1 of 40 3-yr-olds had not previously calved, and in 1993, 8 of 26 2-yr-olds and 2 of 35 3-yr-olds had not previously calved. Mean body weight (BW) collected in fall (at weaning) prior to breeding for females used in 1992 were 294 kg for 2-yr-olds, 390 kg for 3-yr-olds, and 457 kg for ≥4-yr-olds. Mean BW for females used in 1993 were 318 kg for 2-yr-olds, 406 kg for 3-yr-olds, and 467 kg for ≥ 4-yr-olds. Cows were bred by AI after observed/detected estrus for 2 mo (mid-March to mid-May) and then were exposed to clean-up Angus bulls for 1 mo (mid-May to mid-June). Sterile (both epididyectomized and penile-deviated) bulls fitted with chin ball marker devices were used as an aid for estrus detection. Estrus activity was observed twice daily. In the morning females were brought to pens and those detected in estrus the prior evening were bred by AI and those detected in estrus that morning were bred by AI that evening. The first and every fourth cow that was bred by AI was bred to the same sire breed and within each sire breed to the next sire on the list.

Management of the Angus cows was according to normal station practices that were considered typical of the industry. Angus cows were placed on bahiagrass (*Paspalum notatum* Flugge) pastures at the same location throughout the study. Bahiagrass hay (large round bales) was offered free choice to all cows from first frost (approximately November 15) until spring (approximately April 1) when grass became available. Also from first frost until spring, rhizoma peanut (*Arachis glabrata* Benth.) hay (large round bales) was limit-fed as a protein supplement three times weekly at a rate equivalent to 2.3 to 3.2 kg·cow^{-1}·d^{-1} as a substitute for .9 kg·cow^{-1}·d^{-1} of 20% CP range cubes. At times, depending on availability and quality of rhizoma peanut hay, .9 kg·cow^{-1}·d^{-1} of a commercially available 20% CP range cube supplement (≤ 4.72% protein from nonprotein nitrogen) was fed on the ground. Additionally, at the start of calving until spring, cows were supplemented with blackstrap molasses fed in open troughs twice weekly at a rate equivalent to 1.9 kg·cow^{-1}·d^{-1}. Cows had ad libitum access to a mineral mixture (25 to 32% salt, 15 to 18% Ca, 5 to 8% P, ≥ .94% Fe, ≤ .15% Fl, ≥ .10% Cu, ≥ .01% Co, and .0010 to .0015% Se) throughout the year.

Calves were born from late December through early March. Within 24 h of birth, calves were ear-tagged, tattooed, and weighed. Sex of calf, dam identification, and birth date were also recorded. Length of gestation (number of days) was calculated from date of calving minus date of AI. Calves were not creep-fed and bull calves were not castrated. At approximately 8 mo of age (September), calves were weighed, measured for hip height, separated by sex, and weaned. Adjusted 205-d weaning weight and ADG from birth to weaning were calculated.

In 1993 and 1994, within 1 wk of calving, Angus cows with their F_1 calves at side were exposed to sterile bulls fitted with chin ball marker devices to aid in the detection of date of first observed estrus. Cows were observed twice daily for estrus behavior and chin ball marks. In 1993, this was continued until the end of the 2-mo AI breeding season. In 1994, when the 3-mo natural breeding season began, the sterile bulls were replaced with fertile Angus bulls fitted with chin ball marker devices and detection of date of first observed estrus was conducted 2 mo into the breeding season. The interval from date of calving to date of first observed estrus was calculated in 1993 and 1994. Date of pregnancy in 1993 was considered the date of AI confirmed from calving date in 1994, and the interval from date of calving in 1993 to date of pregnancy in 1993 was calculated. In 1994, when Angus cows were bred by natural service to Angus bulls, date of pregnancy in 1994 was calculated from date of calving in 1995 minus 284 d for length of gestation, and interval from date of calving in 1994 to date of pregnancy in 1994 was calculated.

Data were analyzed using the MIXED procedure of SAS (Littell et al., 1996). The initial model used in the analysis included the fixed effects of year, sire breed,

Table 1. Distribution of birth and weaning records by year, sire breed, and sex of calf

Year and record	Brahman[a]		Senepol		Tuli	
	Bull	Heifer	Bull	Heifer	Bull	Heifer
1993						
Birth	20	22	21	21	21	23
Weaning	18	20	19	20	20	22
1994						
Birth	17	23	25	18	18	29
Weaning	14	23	23	18	17	29

[a]In both years one set of Brahman × Angus twin calves were born; one twin calf was removed each year and was not included in the analyses.

calf sex, sire breed x calf sex, cow parity group (group 1 = first parity, group 2 = second parity, group 3 = third parity, and group 4 = fourth or greater parity), year × sire breed, year × calf sex, and year × sire breed × calf sex, and the random effect of sire within sire breed. No interactions with year were significant and they were excluded from the final model. The final model used in the analysis included the fixed effects of year, sire breed, calf sex, sire breed × calf sex, and cow parity group, and the random effect of sire within sire breed. Categorical data (i.e., unassisted calvings and calf survivability) were analyzed for the effect of sire breed using the CATMOD procedure of SAS, and differences were detected using chi-square (SAS, 1989). All data are reported as least squares means ± SE.

Results and Discussion

In 1992, 156 of 167 Angus cows were bred by AI and 128 crossbred calves were born in 1993 (Table 1). In 1993, 180 of 196 Angus cows were bred by AI and 130 crossbred calves were born in 1994. Each year one set of B × A twin calves were born. One of the twin calves was removed from their dam each year and data from the removed calf were not included in the analyses.

Neither year of birth nor cow parity group affected ($P > .10$) calf birth weight. Sire breed ($P < .001$), sex ($P < .001$), and the sire breed × sex interaction ($P < .05$) affected calf birth weight (Table 2). Birth weights of B × A calves were heaviest, those from T × A calves lightest, and those from S × A calves were intermediate. These results agree with those reported for similar genotypes by Holloway et al. (1998). Other researchers have also reported heavier birth weights for Brahman-sired calves than for either Tuli- (Baker, 1996; Herring et al., 1996; Cundiff et al., 1998) or Senepol-sired calves (Butts, 1987). As expected, birth weights of bull calves were heavier ($P < .001$) than those of heifer calves. The interaction of sire breed and sex on calf birth weight seemed to be due to the relatively large difference observed between B × A bull and heifer calves (5.1 kg) as compared to the differences observed between sexes of S × A (1.7 kg) and T × A (2.8 kg) calves. Mean birth weight of B × A bull calves was heavier than that of

any other sire breed and sex combination (38.5 kg vs 29.8 to 33.8 kg). These results are in agreement with others that reported larger differences in birth weight between Brahman-sired bull and heifer calves than between Tuli-sired bull and heifer calves (Browning et al., 1995; Herring et al., 1996). Furthermore, these results are consistent with previous studies that reported sire breed × sex interactions on calf birth weight with large sex differences observed for *Bos indicus* × *Bos taurus* crossbred calves (Gregory et al., 1979; Comerford et al., 1987; Paschal et al., 1991).

Sire breed affected ($P < .01$) the percentage of cows that did not require assistance at calving (B × A, 86.8%; S × A, 97.6%; and T × A, 100%; Table 3). There was also a trend ($P < .10$) for an effect of sire breed on calf survivability from birth to weaning (B × A, 90.4%; S × A, 94.1%; and T × A, 97.8%). A total of 9.6% of B × A calves were lost between birth and weaning and 7.2% were lost between birth and 3 d of age. In general, under our management conditions, calf losses between birth and 3 d of age are due to calving problems, whereas calf losses between 3 d and weaning are due to scours. The losses of the B × A calves within 3 d of birth were associated with calving difficulty, which may be attributed to the heavy birth weights, particularly for the B × A bull calves. Others have also reported calving difficulty for Brahman-sired calves from *Bos taurus* dams, especially for young dams (Notter et al., 1978; Gregory et al., 1979). In contrast, calving difficulty has not been observed in studies using Tuli (Herring et al., 1996; Cundiff et al., 1998) or Senepol (Thrift et al., 1986; Chase et al., 1998) sires on *Bos taurus* cows. Differences in calf survivability for Brahman- and Tuli-sired crossbred calves reported in the present study agree with those reported by other researchers (Baker, 1996; Cundiff et al., 1998); one of those studies also indicated that most of the Brahman-sired calf losses occurred within 3 d of birth (Cundiff et al., 1998).

Year affected the calf age at weaning ($P < .001$), unadjusted weaning weight ($P < .001$), and hip height ($P < .05$) at weaning (Table 2). Some of the differences in age at weaning between years were due to management constraints. The AI breeding season started 5 d earlier

Table 2. Effect of sire breed and sex of calf on preweaning growth traits (least squares means ± SE)

| Trait | Sire breed and sex of calf | | | | | | Sources of variation[a] | | | |
| | Brahman | | Senepol | | Tuli | | | | | |
	Bull	Heifer	Bull	Heifer	Bull	Heifer	Year	Sire breed (SB)	Sex	SB × sex
Birth weight, kg	38.5 ± 1.00	33.4 ± .96	33.8 ± .98	32.1 ± 1.00	32.6 ± 1.03	29.8 ± .96	NS[c]	***	***	*
Age at weaning, d	237 ± 2.9	233 ± 2.7	238 ± 2.8	236 ± 3.0	237 ± 3.0	236 ± 2.7	***	NS	NS	NS
Weaning weight, kg	241.1 ± 5.26	211.6 ± 4.85	200.7 ± 4.91	194.9 ± 4.99	200.1 ± 5.06	193.0 ± 4.65	***	***	***	**
Adjusted weaning weight, kg[b]	215.0 ± 4.21	191.5 ± 3.90	178.8 ± 3.95	174.6 ± 4.00	178.6 ± 4.07	172.1 ± 3.76	NS	***	***	**
ADG from birth to weaning, g	866 ± 19.1	770 ± 17.8	708 ± 18.0	696 ± 18.2	715 ± 18.6	695 ± 17.3	NS	***	***	**
Weaning hip height, cm	108.3 ± .92	103.8 ± .85	100.2 ± .86	98.7 ± .87	99.6 ± .89	98.7 ± .81	*	***	***	*

[a]Cow parity group was not significant for any trait.
[b]Adjusted to 205 d.
[c]NS = not significant (P > .10).
* = P < .05.
** = P < .01.
*** = P < .001.

in the 2nd yr than in the 1st yr, and in the 2nd yr calves were weaned 6 d later.

As with birth weight, sire breed ($P < .001$), sex ($P < .001$), and the sire breed × sex interaction ($P < .05$) affected unadjusted weaning weight, 205-d adjusted weaning weight, ADG from birth to weaning, and hip height at weaning (Table 2). Brahman × A calves grew faster to weaning and were heavier (unadjusted and adjusted weights) and taller at weaning than S × A and T × A calves, whereas S × A and T × A calves had similar weights and hip heights at weaning. These results agree with those reported for similar genotypes by Holloway et al. (1998). Furthermore, the results of the present study are in agreement with others that reported heavier weaning weights for Brahman-sired than for Tuli-sired calves (Baker, 1996; Herring et al., 1996; Cundiff et al., 1998), and in two of those studies Brahman-sired calves also had taller hip heights (Baker, 1996; Herring et al., 1996). Likewise, another study indicated heavier weaning weights for B × A calves than for S × A calves (Butts, 1987). As expected, bull calves were heavier and taller at weaning than heifer calves in the present study. The interaction observed between sire breed and sex for preweaning growth traits (unadjusted weaning weight, 205-d adjusted weaning weight, ADG from birth to weaning, and hip height) was, like birth weight, due to much larger differences between B × A bull and heifer calves (29.5 kg, 23.5 kg, 96 g, and 4.5 cm, respectively) than between S × A bull and heifer calves (5.8 kg, 4.2 kg, 12 g, and 1.5 cm, respectively) and between T × A bull and heifer calves (7.1 kg, 6.5 kg, 20 g, and .9 cm, respectively). Herring et al. (1996), using Brahman, Boran, and Tuli × *Bos taurus* calves, did not observe an interaction between sire breed and sex for weaning traits. However, using Angus, Brahman, or Tuli × *Bos indicus* calves, Browning et al. (1995) reported an interaction of sire breed × sex for weaning

Table 3. Effect of sire breed on calving, calf survival, gestation length, and intervals from calving to first observed estrus and pregnancy of Angus dams (least squares means ± SE)

| | Sire breed | | |
Item	Brahman	Senepol	Tuli
Unassisted calvings, %**	86.8 ± 3.72	97.6 ± 1.64	100.0
Calf survivability			
Birth to weaning, %†	90.4 ± 3.24	94.1 ± 2.55	97.8 ± 1.55
Birth to 3 d, %	92.8 ± 2.84	98.8 ± 1.17	98.9 ± 1.10
3 d to weaning, %	97.4 ± 1.81	95.2 ± 2.32	98.9 ± 1.12
Gestation length, d	283.6 ± .86	281.8 ± .87	282.0 ± .88
Interval from calving to first observed estrus, d	76.2 ± 3.30	75.4 ± 3.26	73.5 ± 3.18
Interval from calving to pregnancy, d	77.3 ± 3.56	83.5 ± 3.47	80.8 ± 3.48

† = P < .10.
** = P < .01.

weight. Furthermore, in a study that included *Bos indicus* × *Bos taurus* calves, Gregory et al. (1979) reported an interaction between sire breed and sex for weaning weight.

Sire breed did not affect ($P > .10$) the length of gestation, interval from calving to first observed estrus, or the interval from calving to pregnancy of Angus dams (Table 3). Length of gestation tended ($P < .10$) to be longer for bull than for heifer calves (283.0 ± .67 vs 282.0 ± .66 d) but was not affected ($P > .10$) by year, cow parity group, or the interaction between sire breed and sex. The absence of a sire breed effect on length of gestation agrees with previous reports for *Bos taurus* dams carrying Brahman- and Tuli-sired calves (Herring et al., 1996; Cundiff et al., 1998); however, gestations were longer in the previous reports than in the present study. In contrast, gestation length differed for Brahman cows carrying Angus-, Brahman- and Tuli-sired calves (Browning et al., 1995).

The interval from calving to first observed estrus was affected by year ($P < .001$; 69 ± 2.9 and 81 ± 2.8 d for 1993 and 1994, respectively) and cow parity group ($P < .01$; 77 ± 9.0, 80 ± 2.9, 74.8 ± 3.1, and 68 ± 2.0 d for first, second, third, and fourth and greater parity dams, respectively) but not ($P > .10$) by sire breed of calf at side (Table 3), sex, or the interaction between sire breed and sex. No effects included in the model for interval from calving to pregnancy were significant. Significant sire breed effects on postpartum interval were reported in another study that used Angus, Brahman, and Tuli sires bred to Brahman cows (Browning et al., 1995). In that study, longer postpartum intervals were reported for Brahman cows with crossbred (A × B and T × B) than for those with purebred (B × B) calves. However, in the present study, using tropically adapted breeds of sires on Angus dams, sire breed of calf at side did not affect the interval from calving to first observed estrus or pregnancy.

Summary/Discussion. Brahman × A calves were heavier at birth, grew faster to weaning, and were heavier and taller at weaning than S × A or T × A calves, which generally did not differ. A significant sire breed × sex interaction was observed for all birth and weaning traits that were measured. This was attributed to a greater difference between B × A bull and heifer calves than between sexes of S × A or T × A calves. Sire breed affected the percentage of unassisted calvings and was lowest for B × A calves. The greater calving difficulty of B × A calves tended to be reflected in poorer calf survivability to weaning, with most losses occurring within 3 d of birth. Sire breed did not affect length of gestation, and sire breed of calf at side did not affect intervals from calving to first observed estrus or pregnancy in Angus dams. The birth, preweaning, and weaning results observed in the present study are in agreement with those reported for Brahman-, Senepol-, and Tuli-sired calves also evaluated in Las Cruces, New Mexico (Winder and Bailey, 1995) and Uvalde, Texas (Holloway et al., 1998). Furthermore, the results reported in the present study are consistent with those reported for Brahman- and Tuli-sired calves also evaluated in Tifton, Georgia (Baker, 1996), Clay Center, Nebraska (Cundiff et al., 1998), and McGregor and Overton, Texas (Browning et al., 1995; Herring et al., 1996). Consistency of results and ranking of sire breeds for these traits across locations and environments suggests the absence of a genotype × environment interaction for the sire breeds and environments involved in this evaluation.

Implications

Major differences in birth and preweaning growth performance may be expected among F_1 crossbred Angus progeny sired by different tropically adapted breeds. Brahman (*Bos indicus*) × Angus calves were heavier at birth and at weaning than were Senepol (*Bos taurus*) × Angus and Tuli (Sanga) × Angus calves. Although the heavier weaning weights observed with Brahman-sired calves would be an advantage for cow-calf producers marketing calves, the heavier birth weights and associated calving difficulties that were attributed to Brahman sires would be a disadvantage. Sire breed of calf at side did not seem to affect rebreeding performance of Angus cows in this study. Further research on postweaning growth, carcass and meat characteristics including meat tenderness, reproductive performance, and maternal evaluation of these breed types is warranted to evaluate the potential usefulness of these tropically adapted sire breeds in the United States.

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